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INTELLIGENCE REPORT

ANALYSIS OF THE CONSTRUCTION OF COMPLEX J
AT THE TYURATAM MISSILE TEST RANGE

DIRECTORATE OF INTELLIGENCE
Office of Research and Reports

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Figure 8. USSR and the United States: Comparison of
Construction Schedules for Selected Assembly
Buildings at the Tyuratam Missile Test Range
and Merritt Island, Florida, [REDACTED]
[REDACTED] (chart) following page [REDACTED]

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ANALYSIS OF THE CONSTRUCTION OF COMPLEX J AT THE TYURATAM MISSILE TEST RANGE*

Summary and Conclusions

The assembly and checkout facilities and the first launch pad of Complex J of the Tyuratam Missile Test Range (TTMTR) in the USSR probably will be ready for initial operations toward the end of the third quarter of 1966. The second launch pad probably will become operational in mid-1967.

Complex J appears to be designed to accommodate very large space vehicles using boosters in the Saturn V class. In view of the pace of construction of Complex J

this complex probably will be used for a greatly expanded space program during this decade. Manned lunar landing and a large space station are definite possibilities. Besides being a launch site, Complex J may serve as the site for major assembly and static testing of the booster stage, although the first few boosters probably will be assembled and static tested elsewhere.

Construction of Complex J has taken place during about the same period as construction of the Project Apollo launcher, Launch Complex 39 (LC 39), at Merritt Island in Florida. When Complex J is completed, the capital investment in it will amount to the equivalent of from about \$300 million to \$360 million,** or from 70 to 85 percent of the investment in LC 39. The program for which Complex J is being built cannot be identified specifically, but the scale of construction and size of capital investment at Complex J suggest a program comparable in size to the US Apollo program.

* The estimates and conclusions in this report represent the best judgment of this Office as of 15 October 1965.

** Throughout this report, dollar values are given in 1963 US dollars, and ruble values are given in new rubles expressed in 1955 prices. New rubles in 1955 prices have been converted to 1955 dollars at the 1955 ruble-dollar ratio for all industrial construction of 0.71 ruble to US \$1. Dollar values were then adjusted to 1963 prices by a factor of 0.792. For direct conversion of new rubles in 1955 prices to 1963 US dollars the value in rubles may be divided by 0.562.

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I. Layout and Design

A. General

1. Layout

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██████████ Complex J at TTMTR consisted of five distinct areas: a construction workers' housing area, a construction support area, an assembly and checkout area, an apartment and technical support area, and a launch area (see Figure 1). At present the complex covers about 9 square miles, and there is ample room for expansion.

The support areas are located on both sides of the branch railroad line in the complex. The construction workers' housing area is on the left side of the line, as the complex is entered, and the apartment and technical support area on the right side. The construction support area is adjacent to the construction workers' housing area and is served by a railroad spur. Farther along the branch line on the right and about 3 miles from the mainline, the assembly and checkout area is located. Within this area, which is also served by a spur line, is the Massive Assembly Building (MAB) and several smaller ancillary buildings.

After passing the assembly and checkout area, the railroad (which is paralleled by a paved road) continues about half a mile, turns gradually to the left, continues about a mile, then turns gradually to the right, and terminates in the launch area. Launch Pad J-1 is about 2 miles from the MAB, about 3 miles from the apartment and technical support area and the construction support area, and about 3.5 miles from the construction workers' housing area.

There are no apparent physical security precautions at Complex J such as have been seen at other complexes. The only fencing visible separates the construction support area from the construction workers' housing area, probably to prevent trespassing and pilfering of materials. Neither the MAB nor the launch area is fenced, although they may be in the future.

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2. Chronology of Construction

25X1D

25X1D Construction of Launch Complex J [REDACTED] when
25X1D work on the construction workers' housing area began, and the first section
25X1D was completed [REDACTED] (see Figure 2). The second phase of housing
25X1D construction b [REDACTED] and was completed in [REDACTED]
25X1D The construction support area, adjacent to the construction workers' hous-
25X1D ing area, was begun in [REDACTED] part was in operation in [REDACTED]
25X1D [REDACTED] and the entire area was completed in [REDACTED] at the same
25X1D time as the first section of the construction workers' housing area. Work
25X1D on other parts of the complex did not start until the construction support
25X1D area had become partly operational. Initial grading and excavation for
25X1D the MAB was first noted in [REDACTED] and work on the apartment
25X1D buildings began in [REDACTED] Work has proceeded rapidly on both
25X1D areas and construction should now be completed. It appears that most of
25X1D the apartments were planned to be ready for occupancy at about the time
25X1D that installation and checkout of equipment should begin in the MAB.

25X1D Work on the Launch Pad J-1, which began in [REDACTED]
25X1D has proceeded rapidly. This pad should be structurally complete in the
25X1D first quarter of [REDACTED] and it could be operational as early as [REDACTED]
25X1D [REDACTED] Launch Pad J-2, about 2,000 feet from J-1, was started in [REDACTED]
25X1D and will be operational about ten months after J-1 -- [REDACTED]

25X1D There appears to have been less than normal seasonal varia-
25X1D tion in the pace of construction at Complex J. The tempo of construction
25X1D increased steadily during the construction period to a peak level in [REDACTED]
25X1D [REDACTED] The average monthly value of construction put in place over the
25X1D first 24 months of development was almost \$4 million, and more than \$9
25X1D million worth of construction was put in place in [REDACTED] At the
25X1D present rate, construction now under way will be completed in January
25X1D 1967. It is estimated that from [REDACTED] through the completion of
25X1D construction, the average monthly value of construction put in place will
25X1D be about \$3 million.

B. Design of Individual Areas

1. Housing Area for Construction Workers

The first project to be started at Complex J was the hous-
ing area for construction workers, which was built in two phases. Dur-
ing the first phase, from [REDACTED] housing and

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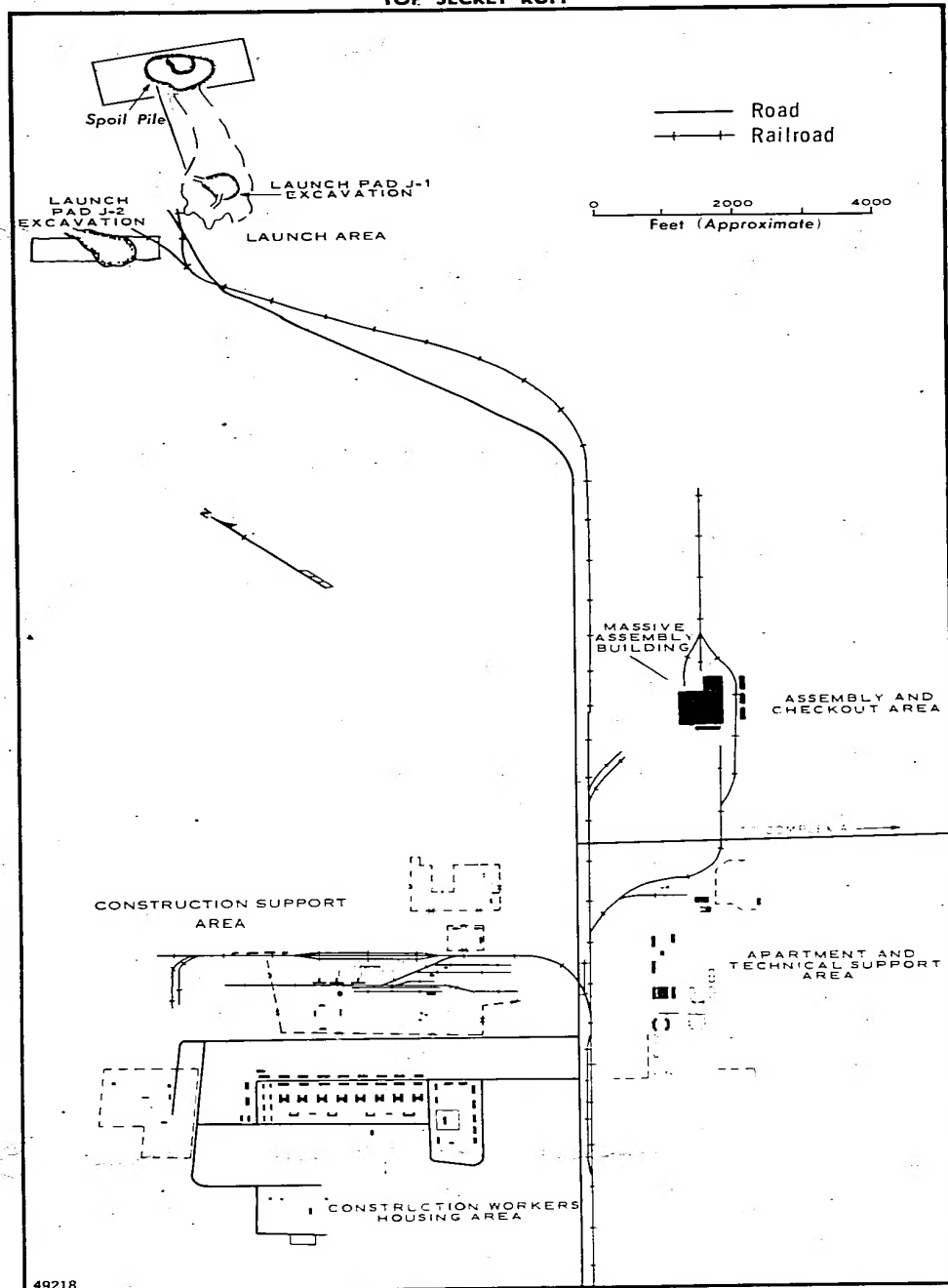
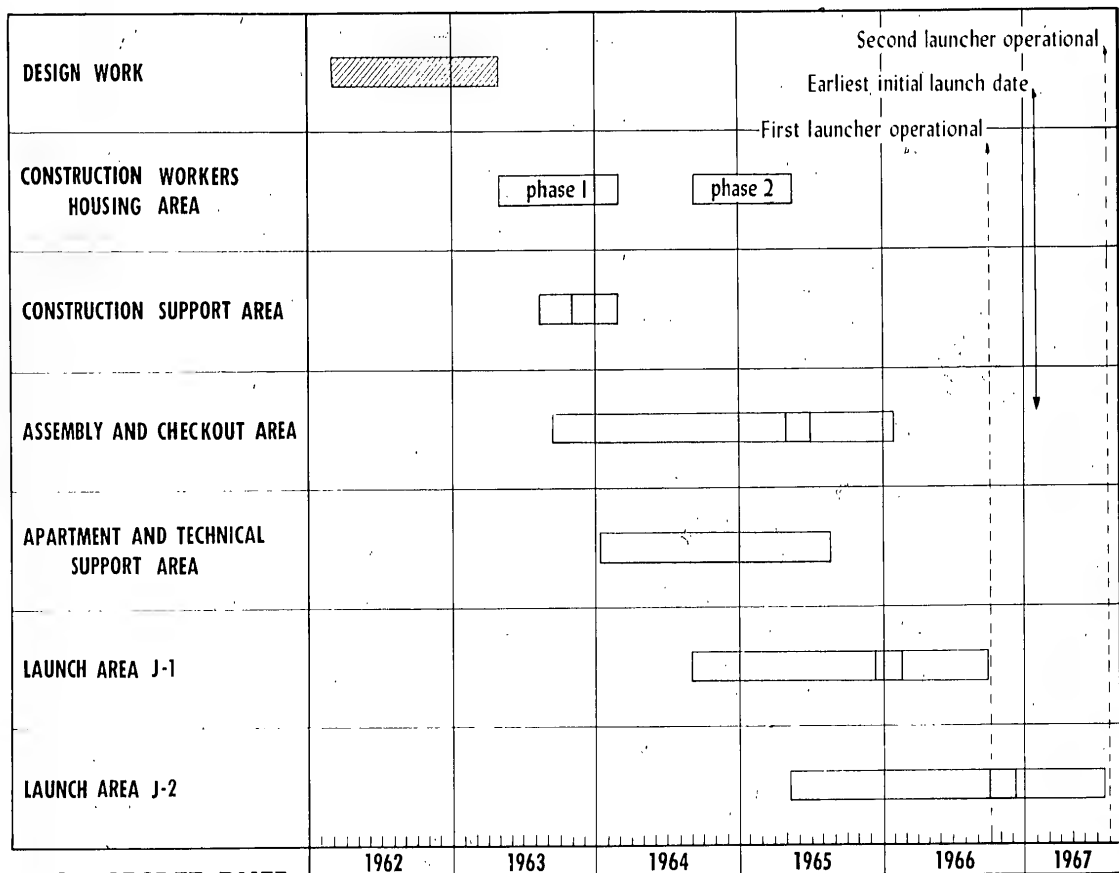


FIGURE 1. USSR: LAYOUT OF COMPLEX J OF THE TYURATAM MISSILE TEST RANGE

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FIGURE 2. USSR: CONSTRUCTION SCHEDULE FOR COMPLEX J
OF THE TYURATAM MISSILE TEST RANGE, 1962-67



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Construction
Installation and checkout of equipment

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ancillary facilities were constructed for about 4,500 workers. Buildings are mainly of the dormitory or barracks type, and construction was accelerated to provide housing for the construction crews as soon as possible. The need for housing was underlined by the fact that the first structures in the area were barracks which appeared even before the start of work on the main access road or railroad line. 1/* During the second phase of housing construction, which started in [REDACTED] and was completed in [REDACTED] facilities for 2,600 workers were built. The buildings in this phase are larger and more elaborate than the earlier structures. Because of the higher quality and timing it seems probable that this housing was initially designed for occupancy by the more highly skilled and highly paid technical workers who will install equipment in the MAB, the launch pads, and the control facilities. For the volume of housing and other buildings in this area and the number of people housed, see Table 1.

The buildings in this area are probably of precast concrete and averaged about a month to erect. The entire area is served by an elaborate underground utilities system supplying water, heat, sewers, and probably electric lines to all buildings. Finally, as each part of the area was completed, it was cleaned up, finish graded, and connected to the rest of the area by a neatly laid out system of sidewalks and streets.

[REDACTED]

25X1B

When Complex J is completed and the construction workers leave, this area probably will be used as housing for support workers, service personnel, and their families. The larger and more elaborate buildings built in the second phase of construction may be converted into multifamily units for family housing, and the rest of the area will probably continue to house single workers and military personnel. After conversion, housing will be available for about 4,500 military or single persons and about 1,700 persons** in family housing.

* For serially numbered source references, see Appendix C.

** Throughout this report, the term persons includes both workers and members of their families.

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Table 1

USSR: Buildings and Housing Space Erected in the Construction Workers' Housing Area
of Launch Complex J
at the Tyuratam Missile Test Range

25X1D

Type of Building	Number of Buildings	Square Feet		Personnel Housed a/ (Individuals)
		Floor Area per Building	Total Floor Area	
Dormitory/barracks	12	3,450	41,400	
Dormitory/barracks	16	5,850	93,600	
Dormitory/barracks	6	9,000	54,000	
Dormitory/barracks	17	7,500	127,500	
Total			316,500	4,500 b/
H-shaped dormitory, high quality	8	17,000	136,000	
H-shaped dormitory, high quality	6	20,350	122,100	
Total			258,100	2,600 c/
Support buildings d/	25		185,800	

a. Data have been rounded to the nearest hundred.

b. Workers or enlisted men's barracks. The estimated floorspace per man is 70 square feet.

c. Foremen or officers quarters. The estimated floorspace per man is 100 square feet. If these dormitories are converted to family quarters, they will house about 1,700 persons (including both workers and members of their families) and have an estimated floorspace per person of 150 square feet.

d. Mess halls, clubs, storage, and the like.

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2. Construction Support Area

25X1D

25X1D

Work on the construction support area [REDACTED] proceeded rapidly, and was completed in [REDACTED] three large concrete batch plants had been erected. These plants are installations in which the dry and wet ingredients of concrete are measured and mixed. The wet concrete is then delivered to the construction site by dump trucks. Although the output of these plants is not known, each of them is as large as or larger than the batch plants supporting other rangehead complexes at Tyuratam. These plants provide the capability to carry out very large continuous pours of concrete which would be needed for the construction of major launchers and static test stands.

The construction support area also contains a steel handling and fabrication facility that includes heavy cranes, storage facilities, and an assembly shed. Extensive rail facilities have been constructed for the delivery of materials and equipment including 15,000 feet of rail sidings having a holding capacity of about 300 standard Soviet boxcars. This area also has a large central heating plant for which underground heating lines radiate to all parts of Complex J. For a list of the major buildings of the construction support area, see Table 2.

3. Assembly and Checkout Area

25X1D

Initial indications that construction was beginning appeared in photographic coverage made [REDACTED] 2/ when the railroad and road were seen being extended beyond the point at which they turned into the construction support area. [REDACTED] a new railroad spur to the right of this extension was also under construction, and clearing and grading was under way at the site of the MAB.

25X1D

25X1D

Construction of foundations for the MAB was identified in [REDACTED] and work has progressed rapidly since that time. By [REDACTED] all structural steel had been erected, [REDACTED] the roof was on and the walls were nearing completion, and [REDACTED] the building appeared to be structurally complete. Assuming that an additional six months will be needed for installation and checkout of equipment, it is estimated that the MAB will be ready to receive its first vehicle or components thereof in [REDACTED]. The MAB is the largest building in terms of volume known to exist in the USSR and probably the second largest in the world after the Vertical Assembly Building (VAB) at LC 39 at Merritt Island, Florida.

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Table 2

USSR: Buildings and Structures Erected in the Construction Support Area
of Launch Complex J
at the Tyuratam Missile Test Range

25X1D [REDACTED]

Type of Building and Structure	Number of Buildings and Structures	Square Feet	
		Floor Area per Building	Total Floor Area
Buildings			
Heating plant	1	13,650	13,650
Fabrication building	1	7,500	7,500
Shop/storage buildings	4	4,800	19,200
Storage building	1	5,625	5,625
Warehouses	4	6,325	25,300
Railserved warehouses	4	varying	45,000
Total			<u>116,275</u>
Structures			
Concrete batch plants	3		
Gantry cranes	2		
Other cranes	3		

Although unique because of its great volume, the design concept of the Soviet building is obviously an adaptation of a Soviet standard design for heavy equipment assembly buildings of large machine building plants. 3/ The spans of the production bays and the longitudinal distance between columns conform with Soviet standard dimensions, and maximum use has been made of standard steel and precast reinforced concrete structural components. The MAB has five parallel bays, each 800 feet long. Three bays are 175 feet high and 125 feet wide, and two bays are 100 feet high and 100 feet wide. The total enclosed volume of the MAB is 67 million cubic feet and its floor area is about 480,000 square feet.

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The assembly and checkout area contains four other buildings thought to be supporting shops, warehouses, and technical laboratories. Three of these, each about 250 by 50 feet, are in a row parallel to the low bay side of the MAB. The fourth building, about 375 by 75 feet, is at one end of the MAB and appears to be connected to it by two overhead passageways.

4. Apartment and Technical Support Area

25X1D

Work on the apartment and technical support area began in [REDACTED] shortly after work started on the MAB. The majority of buildings in this area are typical "Soviet modern," precast concrete apartment buildings of two to three stories. Because of the quality of these buildings and the timing of their construction, they probably will house the scientists, engineers, and technical personnel who will supervise the equipping of the MAB and the launch area and will later direct the programs to be carried out there. Buildings presently under construction should provide family housing for about 5,300 persons (see Table 3).

Photography made in [REDACTED] showed that most of the utility lines had been backfilled and that all of the buildings, except for two apartments still in a midstage of construction, appeared to be nearing completion. 4/ Initial occupancy of these buildings probably began in [REDACTED]. This area may be expanded by new construction because an additional area, equal in size to about half of the developed area, has been provided with underground utilities and is outlined by an improved road. If this additional area is developed with the same building density as the original blocks, the total population of the apartment and technical support area could reach 7,500 to 8,000 persons.

25X1D

25X1D

5. Launch Area

25X1D

25X1D
25X1D

During the [REDACTED] the main access road was extended past the assembly and checkout area. Work, however, did not start in the launch area proper [REDACTED]. Work progressed rapidly and [REDACTED] a large pit about 700 feet long, 500 feet wide, and 120 to 140 feet deep had been excavated. During this time, the water pumping station serving the rangehead was expanded and a large water line was extended from the main part of Complex J to the launch area. It is estimated, therefore, that Launch Pads J-1 and J-2 will be large, wet launchers similar to Pad A-1 in Complex A at Tyuratam (see III, A, 1, below).

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Table 3

USSR: Buildings and Housing Space Erected in the Apartment and Technical Support Area
of Launch Complex J
at the Tyuratam Missile Test Range

25X1D

Type of Building	Number of Buildings	Square Feet		Personnel Housed (Individuals)
		Floor Area per Building	Total Floor Area	
Apartment				
Three-story	8	36,000	288,000	
Three-story	8	46,000	368,000	
Single-story	3	9,350	28,050	
Two-story	3	28,700	86,100	
Two-story	2	10,000	20,000	
Total			790,150	5,300 a/
Technical support				
Shop/warehouse, large	2	32,500	65,000	
Shop	1	17,750	17,750	
Shop/laboratory	2	5,600	11,200	
Shop	1	12,600	12,600	
Total			106,550	

a. Family housing. The estimated floorspace per person is 150 square feet. Data have been rounded to the nearest hundred.

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If the present high rate of construction continues, Pad J-1 should be structurally complete in early 1966 and ready for operation as early as September 1966. Excavation for Pad J-2 [REDACTED] and, assuming a similar rate of progress, completion would follow about ten months later, giving Complex J a two-pad operational capability by mid-1967. For a photograph of the launch area [REDACTED] see Figure 3.

25X11

25X11

II. Capital Investment

A. Total

On the basis that cost of construction would be about 50 percent of the total (see Appendix A), the total capital investment in Complex J is estimated to be about \$300 million. The cost of construction as a share of total capital investment in LC 39 at Merritt Island, Florida, was about 42 percent. If this relationship were valid for Complex J, the total capital investment would be about \$360 million. Therefore, the total capital investment at Complex J is estimated to fall in the range of \$300 million to \$360 million, probably near the low end of the range.*

B. Cost of Construction

1. Buildings and Structures

The cost of construction of buildings and structures has been estimated on a building-by-building basis, using Soviet unit costs. These unit costs were published in a series of Soviet handbooks covering all sectors of the economy and include the following: all direct costs (labor, materials, machinery operations, and the like), overhead, profit, site clearing and drainage, planning and surveying, winter bonus, piecework premiums, home office costs, and costs for temporary buildings (construction sheds, field offices, and the like). 5/ The total cost of construction of buildings and structures was estimated to be about \$106 million.**

* In the graphs, charts, and computations for this report, the exact figure used is \$303.6 million (see Table 4, p. 14, below).

** For methodology, see Appendix A. For a cost estimate of Launch Pad J-1, see Appendix B.

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2. Transportation and Utility Lines

Because Complex J was photographed frequently during the construction period, the lengths and types of major underground utility lines could be determined. Therefore, by the use of the same methodology and handbooks used in estimating the cost of buildings and structures, it was possible to estimate directly the costs of construction of major utility lines, roads, and railroads to be about \$19 million.

3. Other Heavy Construction

A large volume of heavy construction has taken place which cannot be estimated from photography. Among the items in this category are over-all site preparation (including clearing and grubbing and geologic surveys), small pipelines, power and telephone lines, finish grading, seeding, and site cleanup. The amount of about \$13 million (equal to about 10 percent of the cost of constructing buildings, structures, and transportation and utility lines) was added to cover these items.

4. Design and Engineering Services

To the total of all costs of construction (buildings and structures, transportation and utility lines, and other heavy construction), approximately an additional 10 percent (about \$14 million) was added for design and engineering services. Of this amount, half was allocated for design of buildings, structures, and other construction and half was allocated for on-site engineering work including inspection to insure that design specifications were met. This amount is based on US experience in the construction of LC 39 and Soviet data on design costs.

C. Equipment and Installation

Estimating the volume of capital investment for equipment and installation is far more difficult than estimating the cost of construction. With the exception of gantries, umbilical towers, and large transporters, most of the equipment is too small to be seen and cannot be evaluated directly. The best that can be done is to estimate the cost of equipment and installation on the basis of its relationship to the total cost of construction. It is estimated that the cost of construction at Complex J is about 50 percent of the total capital investment and that equipment

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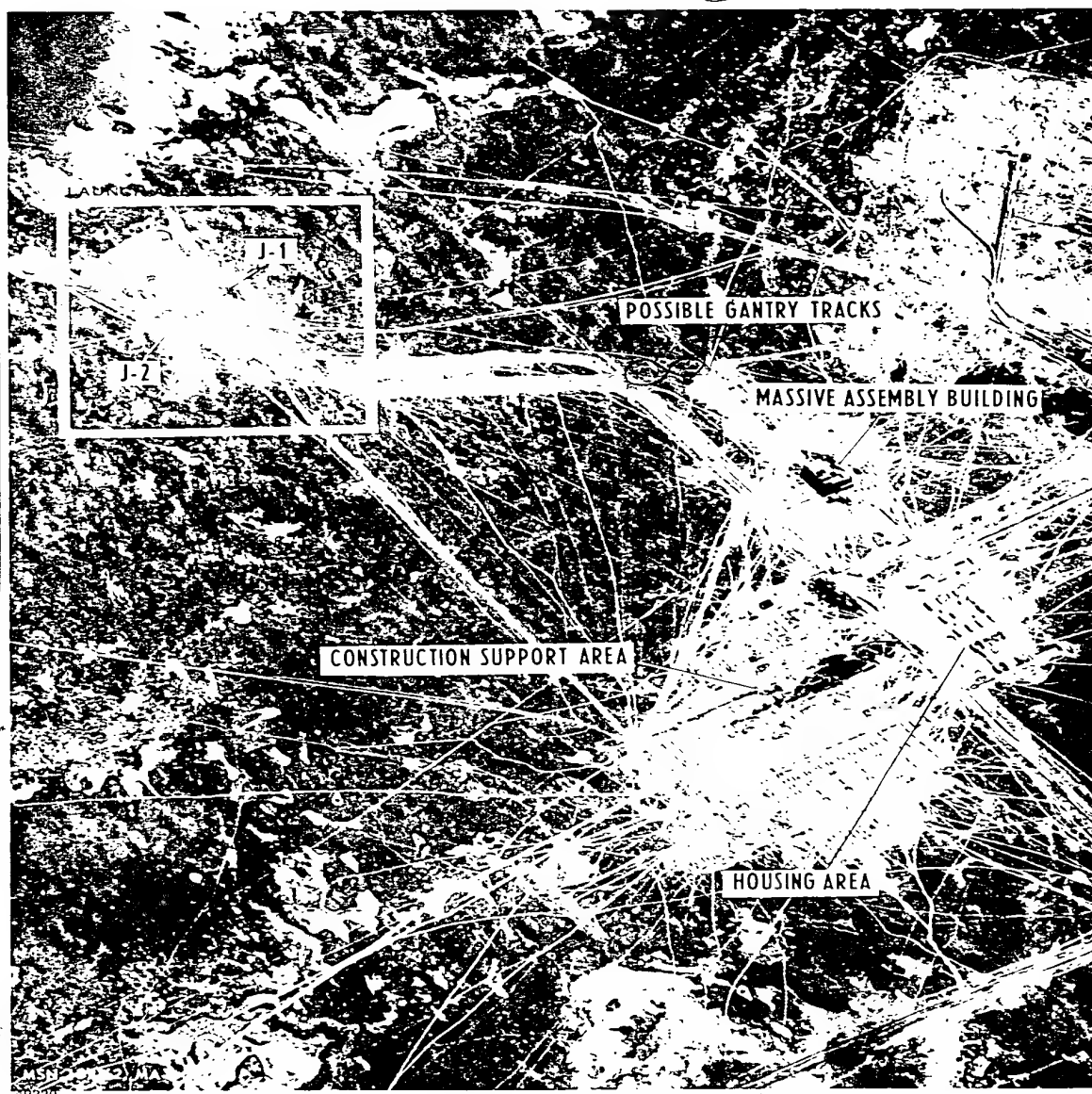


FIGURE 3. USSR: LAUNCH AREA OF COMPLEX J OF THE TYURATAM MISSILE TEST RANGE, MAY 1965

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and installation constitute the remaining 50 percent. Thus the cost of equipment and its installation is estimated to be about \$152 million.*

D. Scheduling

The basis for constructing the schedule of capital investment was the pace of construction.



First, Table 4 presents the annual and total capital investment in Launch Complex J broken down by type of construction and equipment and installation work. Second, Figure 4 presents the monthly capital investment in Launch Complex J categorized by major item of construction and equipment and installation work.

III. Comparisons and Significance

A: Physical Comparisons

1. Launch Pads

Launch Pad J-1 had been under construction about ten months; its pear-shaped excavation, which was about 700 feet long, 500 feet wide, and 120 to 140 feet deep, 7/ had been completed; and foundations had been laid. At that time, large square concrete legs were being built from the floor of the excavation, and a rectangular sump for water recovery was being constructed in the bottom of the pit in front of the site for the launch stand. The large water pipeline was still under construction, running toward the launch area from the MAB, and an alternate pipeline was being built between Complex J and the rangehead pumping station, which was undergoing major expansion. The latest photography indicates that Pad J-1 will be a massive concrete launch stand with a water-cooled flame deflector and water recovery system.

* For methodology, see Appendix A.

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Table 4

USSR: Capital Investment in Launch Complex J
at the Tyuratam Missile Test Range
1962-67

Million 1963 US \$							
Type of Capital Investment	1962	1963	1964	1965	1966	1967	Total
Construction	4.6	15.4	44.7	54.9	28.7	3.5	151.8
Buildings and structures		6.7	32.3	39.9	24.5	3.0	106.4
Transport and utilities		4.6	6.2	7.8	0.2		18.8
Other heavy construction		1.3	3.9	4.7	2.5	0.3	12.7
Design and engineering services	4.6	2.8	2.3	2.5	1.5	0.2	13.9
Equipment and installation		4.7	13.9	49.1	56.5	27.6	151.8
Total	4.6	20.1	58.6	104.0	85.2	31.1	303.6

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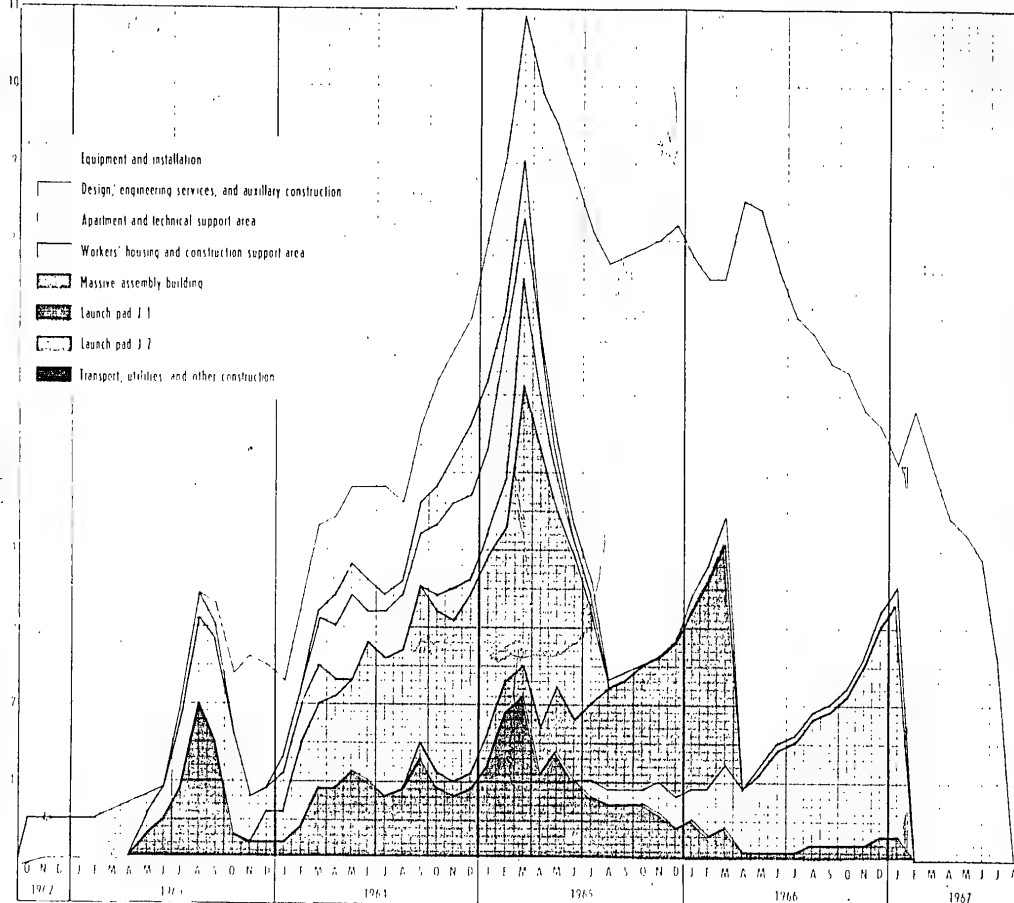


FIGURE 4. USSR: MONTHLY CAPITAL INVESTMENT IN COMPLEX J OF THE TYURATAM MISSILE TEST RANGE, 1962-67

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Current state of the art in the United States and the USSR (as shown by the launchers for Saturn I and Saturn V at Cape Kennedy and Launchers G-3 and G-4 at TTMTR) does not require structures of the Pad J-1 type for launch operations, which are far more expensive to construct than pedestal-type launch pads. Designs such as the J-1 are required for static testing because of the prolonged duration of firing and the immense stresses imposed on the stand during tests. Therefore, it is possible that Pads J-1 and J-2 will serve as both static test stands and launchers.

It is estimated that Pad J-1 will be at least as large as Pad A-1, and on this basis it is possible to estimate the maximum thrust of boosters that could be tested at Pad J-1. Figure 5 is a diagram of Launch Pad A-1 at TTMTR and the Saturn I-C stage test stand at Huntsville, Alabama. It is apparent that these stands are nearly identical in all principal dimensions, and both have the massive structure needed to withstand the stresses involved in static testing. Therefore, Pad J-1 could be intended for static testing as well as launching of rockets in the Saturn V class.*

2. Assembly Buildings

Figure 6 and Table 5 compare the VAB, the MAB, and a large assembly building at Complex G at TTMTR. In terms of volume the MAB is about one-half as large as the VAB. However, it is an order of magnitude larger than the next largest Soviet missile assembly building, which is located at Complex G, and it could easily contain all the other assembly and checkout buildings at TTMTR with room to spare. The larger size of the VAB is dictated by the decision to assemble vertically the entire Saturn V vehicle under the roof.

The size, configuration, and scheduling of construction of the MAB suggest that it may contain the major assembly section of the booster production plant as well as checkout facilities for all stages of the vehicle and its payload. The length of the building suggests that several boosters could be in various stages of assembly simultaneously, and the height of the three main bays indicates that some process, possibly assembly and/or checkout of the booster stage, will be carried out

* Launch Pad A-1 was the first launch stand built at TTMTR and was the only large launcher in the USSR for a long period. It was greatly over-designed in relation to the thrust of the SS-6 booster.

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Table 5

USSR and the United States: Comparison of Selected Assembly Buildings
at Merritt Island, Florida, and at Tyuratam Missile Test Range a/

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Parameter	Unit of Measure	Vertical Assembly Building at Merritt Island	Tyuratam Missile Test Range	
			Massive Assembly Building	Assembly Building at Complex G
Volume	Million cubic feet	125	67	4.2
Roofed area	Thousand square feet	390	460	52.5
Maximum height	Feet	520	170	80
Structural steel	Thousand short tons	55	11.4	N.A. b/
Assembly positions (Saturn V class)	Positions	4	3	1 c/
Cost	Million 1963 US \$	100	40	1.5

- a. All data are approximate except the number of assembly positions.
b. The framework of this building is probably precast reinforced concrete.
c. This building is not large enough for assembly and checkout of a Saturn V class vehicle on an operational basis.

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vertically. Scheduling of construction so that the MAB will be operational about eight months before the first launch pad indicates that the booster stage will require a prolonged period (six to eight months) in the MAB before it is ready for static testing. Construction of the MAB

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It is assumed that such scheduling was deliberate and that therefore the MAB will be needed well ahead of the first launch pad in order to have a booster stage ready for testing as soon as the pad becomes operational.

3. Transporter System

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revealed the start of excavation of parallel trenches about 10 feet wide and 60 feet apart leading from the MAB toward the launch area. These trenches are assumed to be for the foundations for heavy gantry rails and, if so, will be the first such special tracks to connect an assembly building with a launch area. At other Soviet complexes, standard gauge rail lines or roads have been used to bring the vehicle or its components to the launch area. This innovation (bringing special gauge gantry tracks to the MAB) is a further indication of (a) the large size of the vehicle to be launched from Complex J and (b) the probable intention to assemble fully the vehicle and payload in or near the MAB.

The remainder of this section of this report is based on the acceptance of the idea that the trenches noted above are for gantry tracks.* Under this assumption, it is possible to hypothesize a mode of vehicle mating and transport which conforms most closely with the layout of the complex and the construction seen to date.

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The obvious weight-bearing capacity of the foundations, the very broad gauge, and the gentle curve in the alignment leading toward the launch area indicate that a very tall, heavy gantry will use this track. Given the capability of a vertical gantry to travel back to the MAB it is logical to hypothesize that the launch vehicle and payload will be mated and checked out in this gantry, just outside the MAB, and then be transported by the gantry to the launch pad for launch operations (see Figure 7). This method of operation would gain for the USSR the technical advantages of vertical assembly without the great cost of a vertical assembly building.

Other methods of operation seem less likely. On-pad mating and checkout of the vehicle and payload would be inconsistent with the construction of the gantry tracks because such a gantry would be totally unnecessary for the transportation of individual stages to the launch area. Horizontal mating and checkout in the MAB and horizontal transportation to the launch pad is practically ruled out by the curvature of the tracks between the MAB and the launch area.

4. Significance

Combining final booster stage assembly, static testing, and launch operations at the same site would have several advantages. First, it would solve a major transportation problem because transportation of an assembled booster stage from plant to range entirely by rail would require major railroad reconstruction, and use of a combined rail-barge system would be limited to about seven months of the year, when rivers are not frozen. Second, a moderate cost advantage should accrue through the elimination of the need to construct new static test stands for this very large booster stage. Savings could be from about \$30 million (for one stand built at an existing facility) to as much as \$180 million (if a facility such as the Mississippi Test Facility were built). Finally, other things being equal, there should be some advantages through concentration of resources in such areas as transportation, communications, and personal contact between scientists and engineers carrying on different but related tasks.

B. Pace and Timing of Construction

Construction of the VAB in the United States began in August 1963 with the driving of piles for foundations which were made necessary by the geological conditions. Construction work on the building proper

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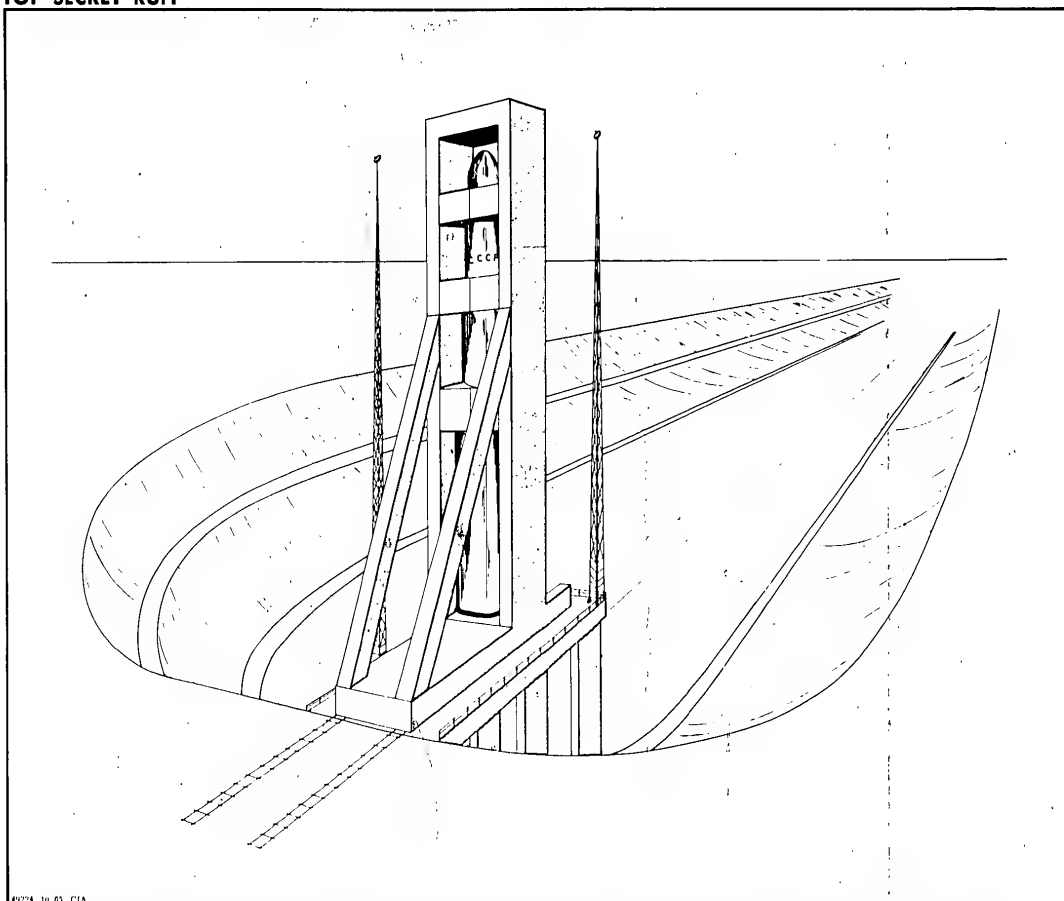


FIGURE 7. USSR: HYPOTHETICAL GANTRY-TRANSPORTER IN POSITION AT LAUNCH PAD J
OF THE TYURATAM MISSILE TEST RANGE

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began in January 1964, structural completion is planned for mid-1965, and installation of equipment should take an additional year. Construction of the crawlerway, the first launch pad, and the control center have proceeded concurrently with construction of the VAB so that Launch Complex 39 at Merritt Island will be ready for checkout of facilities in mid-1966. The first nonflight vehicle is scheduled to arrive at the complex in mid-1966 and will spend about 50 days in the VAB testing equipment, 60 days in testing of the transporter system, and a week for disassembly in the VAB. Complex 39 should be ready for launch operations in the first quarter of 1967.

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Construction of the MAB in the USSR [REDACTED] and it was probably [REDACTED]

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[REDACTED] It is estimated that the installation and checkout of equipment would start at least 2 months before completion of the MAB and would take about eight months. Thus the MAB should be ready to receive the first booster stage or its components in January 1966.

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Construction of the first launch pad, J-1, did not begin until [REDACTED] and construction of transporter tracks between the MAB and the launch pads [REDACTED] structural work was rising at Launch Pad J-1, but the control bunker could not be identified, although there were foundations in the launch area which may be intended for the bunker. There has been no effort to complete Launch Pad J-1 at the same time as the MAB, and it is estimated that it will be [REDACTED]

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C. Capital Investment

Estimates in the NASA budget give the capital investment in Launch Complex 39 as about \$430 million. It is estimated that the investment in Launch Complex J will be equivalent to a range of \$300 million to \$360 million -- from 70 to 85 percent of the US figure. These costs may be compared only in very general terms because of wide variations in construction methods, equipment, materials, and manpower. (For a discussion of the problems of international comparisons in construction, see source 8/.)

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In the Apollo Program, the capital investment in LC 39 amounts to slightly more than 2 percent of the \$20 billion cost of the program. If it is assumed that a similar relationship exists in the Soviet program and it is estimated that the capital investment in Launch Complex J is from 2 to 3 percent of the total cost of the program, the Soviet program cost would fall between \$10 billion and \$18 billion. (For the minimum end of the range, \$0.300 billion divided by 0.03 gives \$10 billion. For the maximum, \$0.360 billion divided by 0.02 gives \$18 billion.)

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APPENDIX

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